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Assessment of Drinking Water in Abbottabad

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Abstract:- Contaminated water is a cause of many water borne diseases, bacteria associated diseases are most commonly emerging which are responsible of increasing mortality and morbidity rate. It is necessary to monitor quality of potable water before supplying it to the consumers. The aim of study is to assess the bacteriological quality of potable water. A study was carried out on drinking water in government and semi government institutes. 1000 ml drinking water of each 8 samples are collected and analyzed for bacteriological by serial dilution and pour plate method. This study showed that 76.8% samples were positive for bacteriological parameters done by serial dilution and pour plate method. Consequently, 76.8% samples were positive for Escherichia coli. Microorganisms that were identified in samples are Escherichia coli and Klebsiella, other are Staphylococcus aureus, Bacillus, Salmonella typhi, Vibrio cholerae, Shigella, Pseudomonas aeruginosa and Streptococcus. Samples collected from drinking water sources were positive for coli forms organisms and indicator bacterial species. It needs continuous screening and treating water sources to utmost important for prevention and control of infectious diseases caused by water borne pathogen microorganisms. Therefore, regular and timely research on bacteriology is necessary to overcome crisis resulted from poor water quality.

I. INTRODUCTION

Water is the most essential element for maintenance of life on earth. It exists in the form of oceans, as fresh water, glaciers, surface and ground water among which the last source of water is suitable for humans. Potable water is a basic right and need of human beings (Mohsin et al., 2013). Worldwide sources of potable water are limited. Yersinia entercolitica, Salmonella, Shigella, Campylobacter, some viruses which include Hepatitis A Virus, Hepatitis E Virus, Rota Virus and some parasites such as Giardia lamblia, Entamoeba histolytica are extremely pathogenic and emerging water borne pathogen worldwide (Ahmad et al., 2017). In developing countries such as Pakistan, the quality of potable water is being hazardous and contaminated continuously for the use of humans due to increase in industries, population and disposal of waste directly onto the ground (Mohsin et al., 2013). According to the environmental profile of Pakistan, water borne diseases lead to approximately 40% of deaths (Inamullah E and Alam A, 2014). 3 million children die every year globally and 98% deaths occur in under developed countries due to extensive water borne diseases outbreaks. Water is the main route of transmission of diseases having large outbreaks (Akbar et al., 2015). Animal and human excreta are cause of water contamination which is cause of many infectious diseases (Akbar et al., 2014). Crucial factor effecting human health is a quality of potable water. 80% of water pollution is due to house hold waste, it was reported by WHO. Water is an essential element and its quality directly associate with the human health (Durmishi et al., 2012). Major source of potable water in both rural areas and urban areas is ground water. Contamination of ground water is caused by human actions rather than natural factors especially in developing countries. Human's actions include discharge of industrial waste, domestic sewage, animal's waste. Consumption of such contaminated water leads to a large number of water borne diseases in under developed countries i.e. a billion or more than a billion diarrheal incidents that occur every year. According to WHO, 4 billion diarrheal cases and 2.2 million deaths were estimated each year. Indicators of fecal contamination are fecal coli forms, total coli forms and E.coli (Pariha et al., 2012). Previous studies regarding drinking water quality have revealed the contamination of drinking water in Abbottabad and the surrounding areas of KPK that requires suitable treatment before use (Ahmed et al., 2014). In Pakistan, 3 million people acquire water borne diseases out of which 1.2 million people die (Tayyab et al., 2017). Major burden on human health is water borne diseases (Bain et al., 2014).

II. METHODS

A. Study Design

The study was carried out at Microbiology laboratory, GPGC Mandian Abbottabad from March 2017 to June 2017. A total 08 drinking water samples for bacteriological analysis were collected from different government and semi government institutes for bacteriological contamination.

B. Study area

Abbottabad was a study area, city of KPK Pakistan which is surrounded by mountains. A total 8 samples were collected from different government institutes and semi government institutes. The selected institutes were; Government Degree College for Girls No 2 (Mandian), Government Postgraduate College No 2 (Mandian), Nawasher Degree College for girls (Nawasher), Pakistan Military Academy (Kakul), Government Degree College for Girls No 1 (Abbottabad City), Government Postgraduate College No 1 (Abbottabad City), COMSATS Institute of Information Technology (Mandian), Ayub Medical College (Mandian). Educational institutes were selected because there is large proportion of water borne diseases in student and this is because of supply of untreated municipal water in educational institutes as well as adjacent areas of institutes. Some

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educational institutes have a facility of bore water but due to mixing of sewage water it is not fit for drinking purpose.

C. Sample Collection

Standard methods were followed for drinking water samples collection, preservation and transportation *i.e.,* water samples were collected in sterilized glass bottles, bottles were properly labeled, before samples collection bottle were rinsed 2 to 3 times with sample water. In order to prevent from any unwanted growth of microbes samples were transported in ice box to laboratory.

D. Bacteriological Analysis

Microbial analysis of water samples were carried out by MPN technique for the enumeration of total coli form in 100ml of water for diagnosis of bacteriological contamination. Presence of coli form was confirmed by the production of acid and gas from the MacConkey broth (lactose broth). The standard of microbial purity for potable water was counted as total coli form/100ml of water sample. MPN values were determined directly by using probability tables. However presence of total coli form may not provide us information about the type of pathogens in water so we used Serial dilution and Pour plate method to identify other pathogens in water. Water samples were inoculated on Nutrient agar, MacConkey agar and Blood agar and incubated at 37^{O}C for 24 hours. After 24 hours these plates were examined and colonies were counted as CFU/ml. Further cultures were processed for the identification of theses pathogens by Gram staining and Biochemical tests (catalase, oxidase and coagulase).

III. RESULTS

To minimize the risk of water borne diseases identification of human pathogenic microorganisms is concerning issues. Due to poor quality of potable water many diseases outbreak. A total 8 water samples were tested from different government and semi government institutes of Abbottabad. Highest CFU/ml was 9.2×10^{8} which was evaluated in sample 3 and lowest CFU/ml was1.4×10^{5} which was evaluated in sample 1 (Table 1).

Samples	CFU/ml		
	M.A	N.A	B.A
S 1	2×10^{5}	1.4×10^{5}	4×10^{5}
S 2	1.86×10^{7}	9.93×10^{7}	2.23×10^{7}
S 3	1.78×10^{8}	9.2×10^{8}	2.26×10^{8}
S4	1.36×10^{8}	3.43×10^{8}	3.36×10^{8}
S5	1.74×10^{7}	1.44×10^{7}	1.42×10^{7}
S 6	1.56×10^{7}	2.48×10^{7}	9.2×10^{7}
S 7	1.2×10^{6}	5.1×10^{6}	2.39×10^{6}
S 8	4×10^{5}	1.6×10^{5}	8×10^{5}

Table 1: CFU/ml

Key: M.A: MacConkey Agar, N.A: Nutrient Agar, B.A: Blood Agar

According to results highest CFU/ml was 9.2×10^{8} and lowest CFU/ml was 1.4×10^{5}as listed in Table 1.

A. Growth of Microbes on Different Culture Medium

Observing morphologies distinct colonies were observed and then for the identification of microbes gram staining and biochemical tests were performed (Table 2).

MacConkey agar is selective and differential culture medium used for selectively isolate Gram negative bacteria, enteric bacilli and differentiate them based on lactose fermentation.

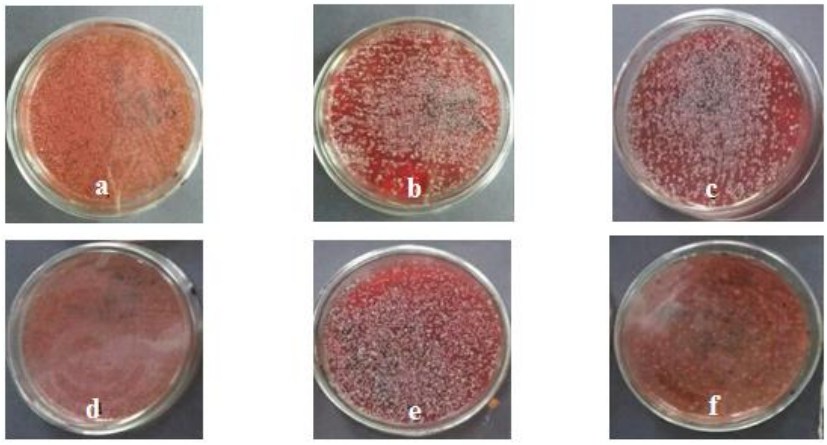

Fig 1:- On MacConkey Agar

Nutrient agar was general purpose medium supporting growth of a wide range of non-fastidious organisms.

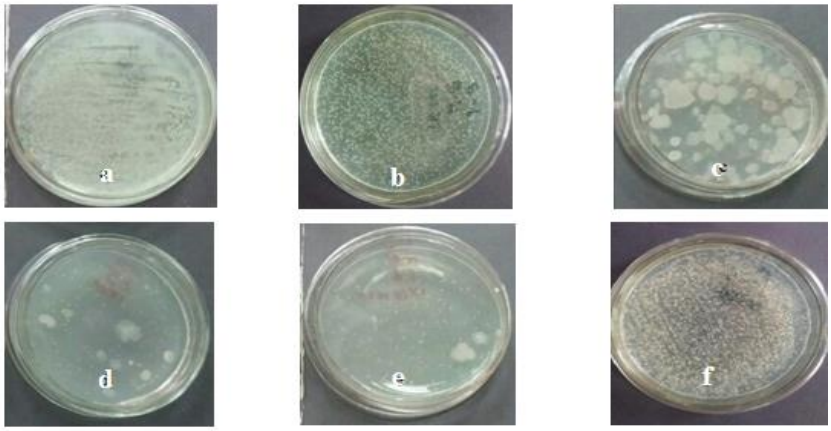

Fig 2:- On Nutrient Agar

Blood agar was used for cultivating fastidious organisms and for determining the hemolytic capabilities of an organism.

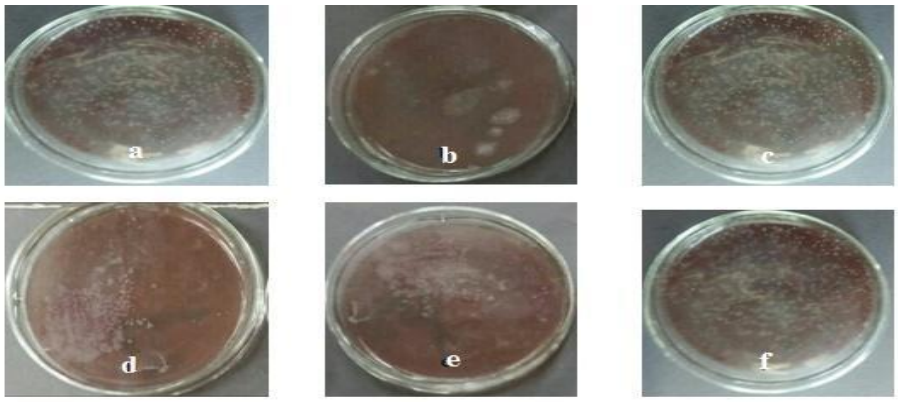

Fig 3:- On Blood Agar

ISSN No:-2456-2165

Bacterial species	Characteristics				
	Morphology	Gram Staining	Oxidase	Catalase	Coagulase
S.aureus	Cocci	+ive	-ive	+ive	+ive
Bacillus	Rod	+ive	-ive	+ive	-ive
S.typhi	Rod	-ive	-ive	+ive	-ive
V.cholera	Coma	-ive	+ive	+ive	-ive
Shigella	Rod	-ive	-ive	+ive	-ive
P.aeruginosa	Rod	-ive	+ive	+ive	-ive
Streptococcus	Cocci	+ive	-ive	-ive	-ive
E.coli	Rod	-ive	-ive	-ive	-ive
Klebsiella	Rod	-ive	-ive	+ive	-ive

Table 2:- Biochemical and Microscopic Characteristics

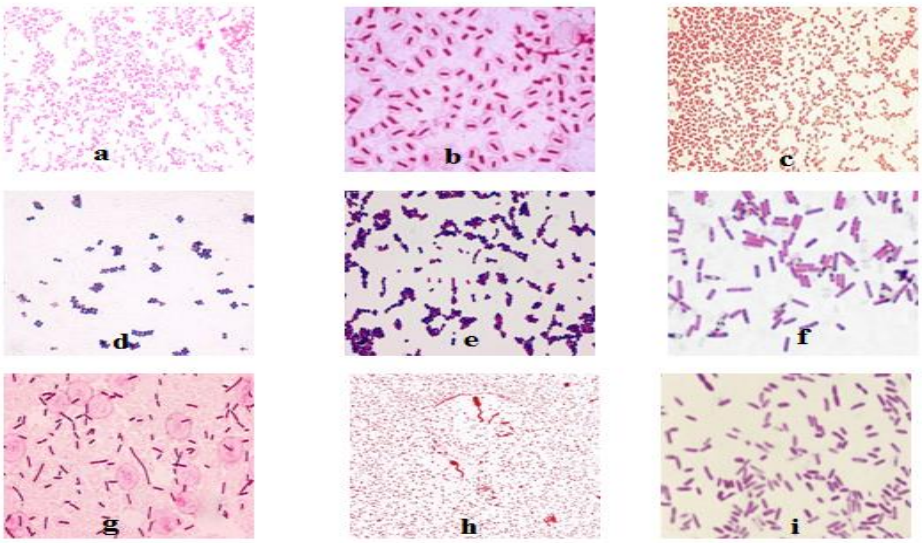

Fig 4:- Microscopic Structures of Identified Organisms

Key: a: *E.coli*, b: *Klebsiella*, c: *P.aeruginosa*, d: *S.aureus*, e: *Streptococcus*,

f: *Bacillus*, g: *S.typhi*, h: *V.cholerae*, i: *Shigella*

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Bacterial species	Samples							
	S1	S2	S3	S4	S5	S6	S7	S8
S.aureus	+ive	-ive	-ive	+ive	-ive	-ive	-ive	-ive
Bacillus	-ive	-ive	+ive	+ive	+ive	-ive	+ive	+ive
S.typhi	-ive	+ive	-ive	+ive	+ive	+ive	+ive	+ive
V.cholerae	-ive	-ive	+ive	-ive	-ive	-ive	+ive	-ive
Shigella	-ive	-ive	-ive	-ive	+ive	+ive	-ive	-ive
P.aeruginosa	-ive	+ive	-ive	-ive	+ive	+ive	+ive	+ive
Streptococcus	-ive	-ive	-ive	-ive	-ive	+ive	-ive	-ive
E.coli	+ive	+ive	+ive	+ive	-ive	+ive	-ive	+ive
Klebsiella	-ive	-ive	-ive	+ive	-ive	-ive	+ive	-ive

Table 3: Isolated and Identified Bacteria

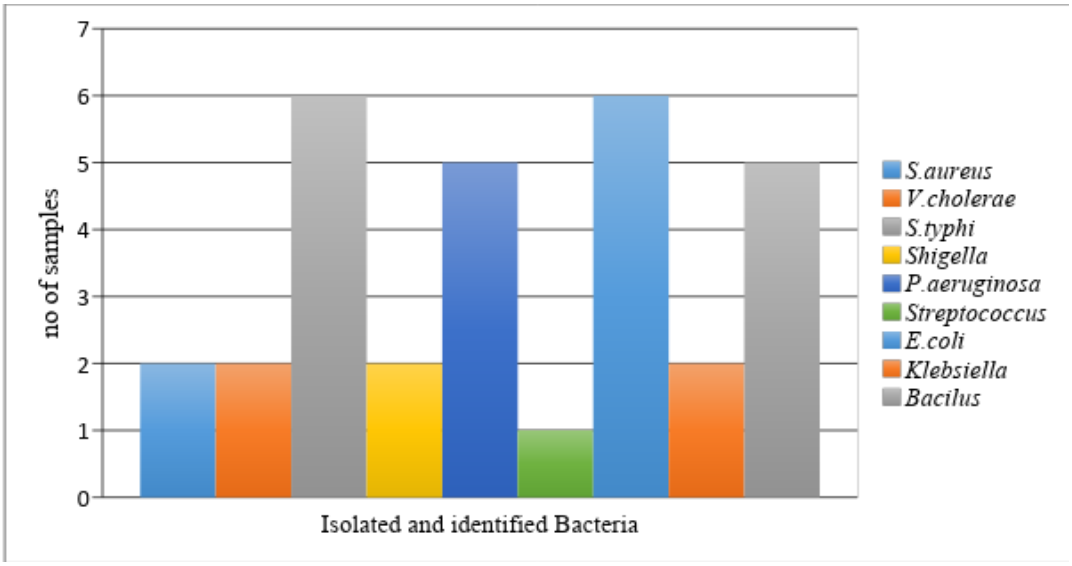

Fig 5:- Isolated and Identified Bacteria

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Samples	Volume of Sample in each Bottle and Test Tube	50ml	10ml	1ml	MPN/100ml
	Number of Bottles and Test Tubes	1	5	5	
S1		1	4	2	20
S2		1	5	4	160
S3		1	3	2	14
S4		1	1	1	5
S5		0	1	2	3
S6		1	3	1	11
S7		1	0	3	6
S8		1	4	4	35

Table 4: MPN/100 ml For Coli form

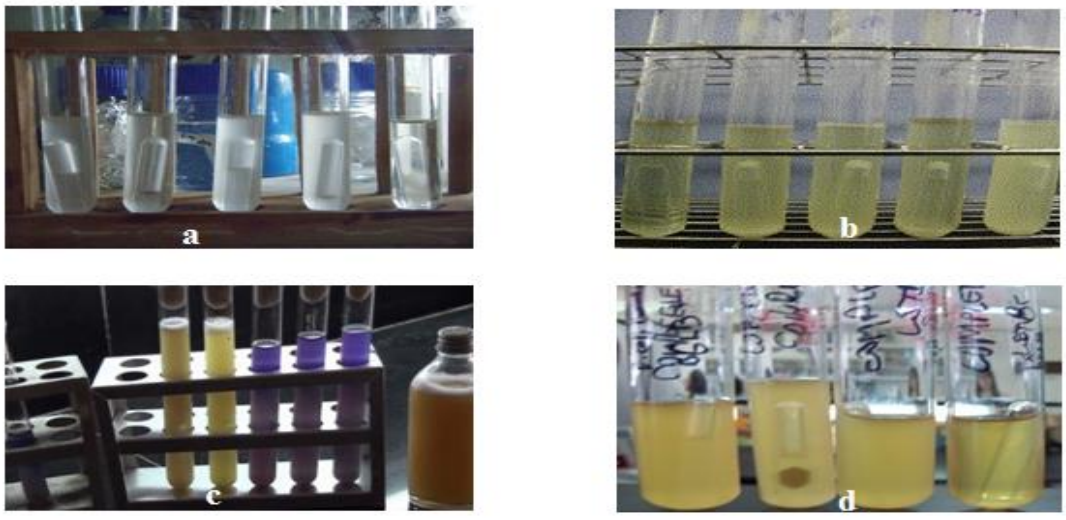

Fig 6:- MPN Technique Tubes Results

IV. DISCUSSION

Microbiological analysis of drinking water quality helps to identify the presence of microbial contaminants; it is an important element of quality control. This study reveals that *E.coli* was found in approximately 76.8% samples. Highest CFU/ml was 9.2×10^{8} (Table 1). Identified microorganism have different biochemical characteristics, mostly were gram negative rods, gram positive rods were also identified (Table 2). These all pathogens cause serious life

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threatening diseases. Ahmed *et al* (2014) conducted a similar study in Abbottabad and he reported *Citrobacter sakazakii*, *Enterobacter cloacae* and *Salmonella choleraesius* in potable water. He also reported 75% secondary, 47% higher secondary and 39% post secondary institutions lack proper filtration system due to which there is 12% prevalence of dysentery, typhoid, diarrhea, hepatitis, abdominal pain and skin infections in students and staff members. Khalid *et al* (2011) conducted a study in Abbottabad and reported that minimum coli form found is 15/100 ml and maximum are unlimited. He also reported due to microbiological contamination water was not found safe for drinking purpose.

Sample 1 contain maximum CFU/ml was 4×10^{5}, minimum was 1.4×10^{5} and microorganisms found were E.coli, Staphylococcus. Sample 2 contain maximum CFU/ml was 9.93×10^{7}, minimum was 1.86×10^{7} and microorganisms found were E.coli, Salmonella typhi and Pseudomonas aeruginosa. Sample 3 contain maximum CFU/ml was 9.2×10^{8}, minimum was $1.78\times10^{8}$and microorganisms found were E.coli, Bacillus, Vibrio cholerae. Sample 4 contain maximum CFU/ml was 3.36×10^{8}, minimum was 1.36×10^{8} and microorganisms found were E.coli, Staphylococcus, Bacillus, Salmonella typhi and Klebsiella. Sample 5 contain maximum CFU/ml was 1.74×10^{7}, minimum was 1.42×10^{7} and microorganisms found were Bacillus, Pseudomonas aeruginosa and Salmonella typhi, Shigella. Sample 6 contain maximum CFU/ml was 9.2×10^{7}, minimum was 1.56×10^{7} and microorganisms found were E.coli, Streptococcus, Shigella, Pseudomonas and Salmonella typhi. Sample 7 contain maximum CFU/ml was 5.1×10^{6}, minimum was $1.2\times10^{6}$and microorganisms found were Klebsiella, Bacillus, Vibrio cholerae, Pseudomonas and Salmonella typhi. Sample 8 contain maximum CFU/ml was 8×10^{5}, minimum was 1.6×10^{5} and microorganisms found were E.coli, Bacillus, Pseudomonas and Salmonella typhi (Table 1 and 3).

Quality of drinking water deteriorates day by day due to many factors such as increase urbanization, defective water supply system, improper disposal of waste due to which many water borne diseases are emerging must reported is typhoid and diarrhea. Samples that are analyzed are considered unfit for drinking purpose. Ali et al (2012) conducted a study in new Urban Peshawar in which he revealed that drinking water samples from different sources were contaminated with 60% faecal coli forms and 40% Escherichia coli. In this study we have identified different organisms on the basis of their biochemical and Microscopic characteristics. S.aureus is identified on the basis of these characteristics; Cocci (bunches), Gram positive, Oxidase negative, Catalase and Coagulase positive. Bacillus is identified on the basis of following characteristics; Rod shaped, Gram positive, Oxidase negative, Catalase positive and Coagulase negative. S.typhi is identified on the basis of these characteristics; Rod shaped, Gram negative, Oxidase negative, Catalase positive and Coagulase negative. Vibrio cholerae is identified on the basis of following characteristics; Comma shaped, Gram negative, Oxidase positive, Catalase positive and Coagulase negative. Shigella is identified on the basis of these characteristics; Rod shaped, Gram negative, Oxidase negative, Catalase positive and Coagulase negative. P.aeruginosa is identified on the basis of following characteristics; Rod shaped, Gram negative, Oxidase positive, Catalase positive and Coagulase negative. Streptococcus is identified on the basis of these characteristics; Cocci (chain), Gram positive, Oxidase negative, Catalase and Coagulase negative. E.coli is identified on the basis of following characteristics; Rod shaped, Gram negative, Oxidase negative, Catalase and Coagulase negative. Klebsiella is identified on the basis of following characteristics; Rod shaped, Gram negative, Oxidase negative, Catalase positive and Coagulase negative (Table 2).

Inamullah, et al (2014) conducted a study in Peshawar in which he showed that 84.35% samples were contaminated with coli form and considered unfit for drinking purpose. A similar study was conducted in Peshawar had reported that Escherichia coli, Pseudomonas aeruginosa, Vibrio cholerae, Salmonella, Shigella, and Staphylococcus aureus were present in potable water. Total coli form was <1.1 to 280 MPN/100 ml. 40% samples were contaminated with Vibrio cholera and only one sample was contaminated with Pseudomonas aeruginosa (Khan, et al., 2013). From study it was concluded that 98% samples were contaminated with coli form. Sample 1 have 20 MPN/100ml. Sample 2 have 160 MPN/100ml. Sample 3 have 14 MPN/100ml. Sample 4 have 5 MPN/100ml. Sample 5 have 0 MPN/100ml. Sample 6 have 11 MPN/100ml. Sample 7 have 0 MPN/100ml. Sample 8 have 35 MPN/100ml. Highest MPN/100ml was 160 MPN/100ml (Table 4).

This study also reveals that about 76.8% of samples were contaminated with pathogenic water borne organisms. This study also reveals that drinking water is not fit for drinking purpose and it is the major cause of many water borne diseases. Khan *et al* (2017) conducted as similar study in Rawalpindi, he reported 67.8% water samples were unfit for drinking purpose and Coli form was the most common organisms isolated. Sarwar, *et al* (2011) conducted a study in Peshawar in which he showed that 43% of the water samples are polluted with *E. coli.*

This study reveals that despite of coli form other microorganism are also present in water and cause serious diseases like cholera, typhoid, diarrhea etc. Proper measures should be taken to control contamination of drinking water to overcome many water borne diseases.

V. CONCLUSION

The bacteriological analysis reveals that 76.8% of drinking water samples were contaminated with different microorganisms. This result indicates that drinking water of Abbottabad city institutes is highly vulnerable to bacterial contamination which is serious threat to students as well as other peoples because same municipal water is supply to

houses due to which many water borne diseases outbreak. Domestic waste water, sewage and land runoff were discharged improperly in water bodies that's way water quality deteriorates. To reduce fecal contamination deep water drilling can be done. Drinking water should be stored in properly constructed tanks well protected from seepage of waste water. This will help to protect water from waste water and other pollutants. Public awareness program should be conducted to address importance of water quality so people become aware of water borne diseases.

REFERENCES

[1]. Ahmed, A. B., Barq, M. G., & Javed, S. (2017). Bacteriological and Physiochemical Analysis of Drinking Water from Different Areas of District Gujrat, Pakistan. Ijabf, 1(1), 25-33.

[2]. Ahmad, M. R., Ahmad, A. F., & Sharma, H. K. (2015). Assessment of microbiological quality of drinking water treated with chlorine in the Gwalior city of Madhya Pradesh, India. African Journal of Environmental Science and Technology, 9(5), 396-401.

[3]. Ahmad, N., Waqas, M., Zareen, K., Rehman, H. U., Din, J. U., Bayan, R., Afridi, S. (2017). Bacteriological analysis of well water in distract Swat KPK Pakistan. Journal of Entomology and Zoology Studies, 5(1), 403–406.

[4]. Ahmed, T., Pervez, A., Mehtab, M., &Sherwani, S. K. (2014). Assessment of drinking water quality and its potential health impacts in academic institutions of Abbottabad (Pakistan). Desalination and Water Treatment, 54(7), 1819-1828.

[5]. Akbar, N., Ayaz, S., Rahman, S., Khan, S., Khan, N. S., Noor, A. A., Waqar, M. (2014). Molecular detection of Entamoebahistolytica in different water sources of district Peshawar, Pakistan. Annual Research & Review in Biology, 4(9), 1461-1470.

[6]. Akbar, N., Ayaz, S., Khan, M. A., Rahman, S., Khan, S., Khan, S. N., & Saeed, S. (2015). Molecular Detection of Cryptosporidium parvum in Different Water Sources of District Peshawar, Pakistan. Advances in Biological Research, 9(5), 344-349.

[7]. Ashbolt, N. J. (2015). Microbial contamination of drinking water and human health from community water systems. Current environmental health reports, 2(1), 95-106.

[8]. Antony, R. M., &Renuga, F. B. (2012). Microbiological analysis of drinking water quality of Ananthanar channel of Kanyakumari district, Tamil Nadu, India. *RevistaAmbiente&Água*, *7*(2), 42-48.

[9]. Ayaz, S., Khan, S., Khan, S. N., Bibi, F., Shamas, S., & Akhtar, M. (2011). Prevalence of zoonotic parasites in drinking water of three districts of Khyber Pakhtunkhwa Province, Pakistan. Pakistan journal of life and social sciences, 9(1), 67-69.

[10]. Ali, S. S., Anwar, Z., &Khattak, J. Z. K. (2012). Microbial analysis of drinking water and water distribution system in new urban Peshawar. Current Research Journal of Biological Sciences, 4(6), 731-737.

[11]. ANWAR, M. S. S., Lateef, S., & SIDDIQI, G. M. (2010). Bacteriological quality of drinking water in Lahore. Biomedica, 26(1), 66-69.

[12]. Bain, R., Cronk, R., Wright, J., Yang, H., Slaymaker, T., & Bartram, J. (2014). Fecal contamination of drinking-water in low-and middle-income countries: a systematic review and meta-analysis. PLoS medicine, 11(5), e1001644.

[13]. Durmishi, B. H., Ismaili, M., Shabani, A., &Abduli, S. (2012). Drinking Water Quality Assessment in Tetova Region. American Journal of Environmental Sciences, 8(2), 162–169.

[14]. Eliku, T., &Sulaiman, H. (2015). Assessment of physico-chemical and bacteriological quality of drinking water at sources and household in Adama Town, Oromia Regional State, Ethiopia. African Journal of Environmental Science and Technology, 9(5), 413-419.

[15]. HOXHA, E., & HAMZARAJ, E. (2017). ASSESSMENT OF DRINKING WATER SAMPLES OF DIFFERENT LOCALITIES IN FIER DISTRICT. ASSESSMENT. Interdisplinary Journal of Research and Development, 4(2), 39–44.

[16]. Iftikhar, B., Bashirullah, N., Ishtiaq, M., Khan, S. A., Siddique, S., &Ayaz, T. (2016). CHEMICAL QUALITY ASSESSMENT OF DRINKING WATER IN DISTRICT PESHAWAR, PAKISTAN. Khyber Medical University Journal, 8(4), 171.

[17]. Inamullah, E., & Alam, A. (2014). Assessment of drinking water quality in Peshawar, Pakistan. Bulgarian Journal of Agricultural Science, 20(3), 595–600.

[18]. Khalid, A., Malik, A. H., Waseem, A., Zahra, S., &Murtaza, G. (2011). Qualitative and quantitative analysis of drinking water samples of different localities in Abbottabad district, Pakistan. International Journal of Physical Sciences, 6(33), 7480-7489.

[19]. Khan, F. A., Ali, J., Ullah, R., &Ayaz, S. (2013). Bacteriological quality assessment of drinking water available at the flood affected areas of Peshawar. Toxicological & Environmental Chemistry, 95(8), 1448-1454.

[20]. Khan, M. J., Ali, M. F., & Hassan, M. (2017). MICROBIAL EVALUATION OF DRINKING WATER AND FREQUENCY OF BACTERIAL ISOLATES FROM RAWALPINDI PAKISTAN. Pakistan Journal of Pathology, 28(1), 28-33.

[21]. Mohsin, M., Safdar, S., Asghar, F., & Jamal, F. (2013). Assessment of drinking water quality and its impact on residents health in Bahawalpur City. International Journal of Humanities and Social Science, 3(15), 114–128.

[22]. Muhammad, N., Banoori, N., Akbar, A., Azizullah, A., Khan, M., Qasim, M., & Rahman, H. (2016). Microbial and toxic metal contamination in well drinking water: potential health risk in selected areas of Kohat, Pakistan. Urban Water Journal, 14(4), 394-400.

[23]. Miner, C. A., Dakhin, A. P., Zoakah, A. I., Zaman, M., &Bimba, J. (2016). Physical and microbiological quality of drinking water sources in Gwafan community, Plateau State, Nigeria. Pyrex J. Res. Environ. Stud, 3, 1-6.
[24]. Ohanu, M. E., Udoh, I. P., & Eleazar, C. I. (2012). Microbiological analysis of sachet and tap water in Enugu State of Nigeria. Advances in Microbiology, 2(12), 547–551.
[25]. Olanipekun, E. A. (2014). Quantitative and Qualitative Assessment of Drinking Water Sources in Ile-Ife and Environs. American Journal of Engineering Research, 3(8), 90–100.
[26]. Parihar, S. S., Ajit, K., Ajay, K., Gupta, R. N., Manoj, P., Archana, S., & Pandey, A. C. (2012). Physico-chemical and Microbiological analysis of underground water in and around Gwalior city, MP, India. Research Journal of Recent Sciences, 1(6), 62–65.
[27]. Pant, N. D., Poudyal, N., & Bhattacharya, S. K. (2016). Bacteriological quality of bottled drinking water versus municipal tap water in Dharan municipality, Nepal. Journal of Health, Population and Nutrition, 35(1), 17.
[28]. Richard, R. L., Ithoi, I., Abd Majid, M. A., Wan Sulaiman, W. Y., Tan, T. C., Nissapatorn, V., & Lim, Y. A. L. (2016). Monitoring of waterborne parasites in two drinking water treatment plants: a study in Sarawak, Malaysia. International journal of environmental research and public health, 13(7), 641.
[29]. Rafiei, A., Rahdar, M., & Valipour Nourozi, R. (2014). Isolation and Identification of Parasitic Protozoa in Sampled Water From the Southwest of Iran. Jundishapur Journal of Health Sciences, 6(4), 10–13.
[30]. Sarwar, G., Khan, J., Iqbal, R., Afridi, A. K., Khan, A., &Sarwar, R. (2011). Bacteriological analysis of drinking water from urban and peri-urban areas of Peshawar. Journal of Postgraduate Medical Institute (Peshawar-Pakistan), 18(1).
[31]. Sidhu, S., Malhotra, S., Devi, P., & Gupta, A. (2016). Bacteriological analysis of the drinking water from different schools in Northern India: A concern in developing countries. International Journal of Medical Research and Review, 4(04).
[32]. Silva, D. A., Cesar, J. J., Januário, A., Júnior, B., Guimarães, A. B., Souza, S. F. D. E., Vilas, G. (2015). Microbiological and Parasitological Examination of Water From Vale Verde District , Minas Gerais , Brazil. Brazilian Journal of Surgery and Clinical Research, 12, 12–14.
[33]. Tabor, M., Kibret, M., &Abera, B. (2011). Bacteriological and physicochemical quality of drinking water and hygiene-sanitation practices of the consumers in bahirdar city, ethiopia. Ethiopian journal of health sciences, 21(1), 19-26.
[34]. Tayyab, M., Haseeb, A., Rehman, H., Saeed, K., Ali, S., Naveed, M., Javed, A. (2017). Detection of Giardia lamblia by microscopy in different water sources of district D . I Khan , KP , Pakistan. Journal of Entomology and Zoology Studies, 5(3), 1–5.
[35]. Tsega, N., Sahile, S., Kibret, M., & Abera, B. (2013). Bacteriological and physico-chemical quality of drinking water sources in a rural community of Ethiopia. African health sciences, 13(4), 1156-1161.
[36]. Wang, H., Edwards, M., Falkinham, J. O., & Pruden, A. (2012). Molecular survey of the occurrence of Legionella spp., Mycobacterium spp., Pseudomonas aeruginosa, and amoeba hosts in two chloraminated drinking water distribution systems. Applied and environmental microbiology, 78(17), 6285-6294.